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Channel Shoaling with Deepening of Houma Navigation Channel at Cat Island Pass, Louisiana

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ABSTRACT

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This study evaluated the potential increase in shoaling and associated sources of sediment as a result of proposed channel improvements for the Houma Navigation Channel in the vicinity of Cat Island Pass, Louisiana. Using morphologic change data and historical maintenance dredging rates, historical and forecasted with-deepening sediment budgets were developed. Conclusions from this study were that deepening the channel from 5.5 m to 6.1 m relative to Mean Low Gulf, a local low water datum, would increase the shoaling rate from the present 191,000 m^3/year to 220,000 m^3/year, and the likely source of shoaling would be sediment that is presently bypassed naturally. It was recommended that all environmentally-acceptable sediment dredged from Cat Island Pass be placed on the downdrift barrier island, East Island, part of the Isle Dernieres barrier island system. Clays and silts should be placed on the bayside of the island and sand similar to or coarser than the existing beach sand should be placed downdrift of the nodal zone on the Gulf side of East Island. Historically, sediment dredged from Cat Island Pass has been placed in designated dredged material disposal sites located 760 m west of the channel. Based on morphologic change in the region from 1980 to 2006, it appears that sediment may be transported from this placement site to deposit back into the channel. It is recommended that, if sediment cannot be placed on either East Island or Timbalier Island, that the dredged material disposal site be moved further to the west, away from the channel. Finally, based on movement of Timbalier Island and Cat Island Pass over the past 100 years, it is recommended that the channel be moved further to the west to avoid future impingement by Timbalier Island. Based on the results of this and other studies of the Houma Navigation Channel, channel realignment was approved in 2009, and authorization of the deepened channel is being requested during 2010.

ADDITIONAL INDEX WORDS: *Shoaling, infilling, sediment transport, sediment budget, regional sediment management, channel deepening and widening.*

INTRODUCTION

The U.S Army Corps of Engineers has a mission to provide safe, reliable, and efficient navigation through the Nation's waterborne transportation systems (channels, harbors, and waterways) for the movement of commerce, to maintain national security, and to facilitate recreation. The Corps' navigation mission requires dredging through as many as 600 coastal inlets, bays, estuaries, and rivers to maintain these channels in the United States. Many of these navigation channels have been deepened, widened, and lengthened to accommodate larger vessels, greater transit speed, and to increase maneuverability. These channel expansions have led to increased maintenance dredging requirements as the increased dimensions create a more efficient trap for sediment being transported in the littoral zone. Sediment shoaled in the channel represents a sink to the littoral system, and best practices dictate that the dredged sediment be placed on downdrift beaches or within the downdrift littoral zone to restore natural transport processes. This paper presents a study that was conducted to evaluate the increase in shoaling with channel improvements and recommend dredged material placement zones to best maintain regional sediment transport patterns.

The U.S. Army Engineer District, New Orleans (MVN) has maintained the 59 km Houma Navigation Channel (HNC)[1] at Cat Island Pass at 5.5 m depth relative to Mean Low Gulf (MLG)[2] and 91 m bottom width since 1974. The HNC is located in Louisiana on the northern Gulf of Mexico, and extends from Houma, Louisiana through Cat Island Pass. The inlet is bordered by Timbalier Island on the east and East Island, part of the Isle Dernieres islands, on the west. In 1998, the channel at

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[1]From Houma, LA (Mile 0) to Mile 36, the channel dimensions are 46 m width and 4.6 m deep.

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Cat Island Pass was realigned 360 m to the west to avoid Timbalier Island as it migrated towards the channel (Figure 1).

The HNC has been evaluated for deepening to 6.1 m MLG and extending the channel length by 0.4 km which would generate 10 million cubic meters of new work dredged material along the entire length of the channel. Presumably, the deeper and longer channel would also require more maintenance dredging as it would be more efficient at capturing littoral sediments. For the HNC in the vicinity of Cat Island Pass, consideration of the regional littoral system requires an understanding of how the deepened channel will change coastal processes and morphology in the region, and points to the need for development of a plan to mitigate any negative consequences of the channel deepening and future maintenance.

This study evaluated existing information (literature, data, and dredging history) to develop an understanding of historical and potential future with-deepening processes at the site, and to provide information for use in developing a dredged material placement plan for the deepened channel. The barrier islands adjacent to Cat Island Pass are critically eroding and migrating rapidly. These barrier islands must be maintained as morphologic features to sustain the low-energy, lower-salinity estuarine characteristics of Timbalier Bay and the fragile interior wetlands. In addition, future migration of the islands may alter tidal currents and sediment transport in Cat Island Pass. It may be necessary to relocate the HNC at Cat Island Pass further west to reduce channel shoaling. Ideally, the dredged sediment will be placed on the adjacent barrier islands such that sediment would remain in the barrier island system and not shoal in the channel. Finally, it is not clear what the source of the shoaled sediment would be, whether it would be from the adjacent barrier islands, offshore shoals, or from within the estuary.

In this study, existing historical data and available literature were evaluated to address these questions:

(a) What will be the increase in channel shoaling, if any, with channel deepening?

(b) What will be the source of the shoaled sediment? Will the adjacent bathymetry increase in depth, or will adjacent barrier islands be eroded?

(c) Should the channel be realigned to reduce maintenance dredging rates?

(d) Based on (a) and (b), what are the recommend placement locations on Timbalier and East Islands to best restore the islands? Are there certain placement locations that will be more likely to minimize transport of placed sand back into the channel?

To address these questions, historical and with-project sediment budgets were developed from existing bathymetric and shoreline position data, an analysis of maintenance dredging rates, and previous studies at the site.

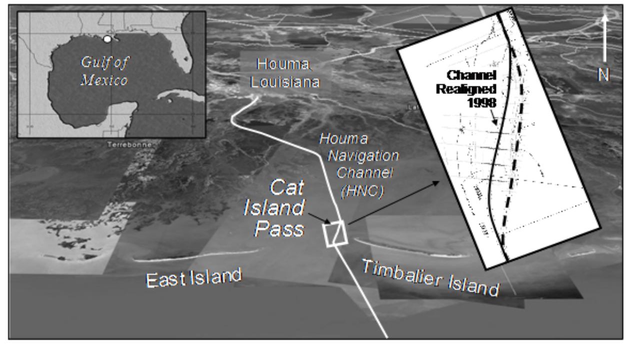


Figure 1. Houma Navigation Channel, Cat Island Pass, and adjacent barrier islands.

STUDY AREA

Timbalier and East Islands, adjacent to Cat Island Pass, were formed as old Mississippi River deltas, abandoned by the river, were reworked by coastal processes. Terrebonne Bay and the barrier islands within the HNC study area were formed as the Teche delta (formed 3500-2800 years before present) and LaFourche delta (formed 1000-300 years before present) eroded, compacted, and subsided. Sediment to nourish the barrier islands in the study area is no longer provided by the Mississippi River or its tributaries. Littoral sand is presently derived through cannibalism of existing headlands and islands (Penland and Boyd, 1981). For example, Timbalier Island is primarily a spit feature that has separated from LaFourche headland to the east. Sand forming the East Island and the Isle Dernieres has been reworked from the Teche and La Fourche deltas.

Penland *et al*. (2005) calculated shoreline change in Louisiana over the past century and past 30 years equal to -6.1 and 9.4 m/year, respectively. Rapid erosion is experienced by the majority of coastal Louisiana, with the only accretion observed in areas of the actively depositing deltas of the Mississippi and Atchafalaya Rivers. The high erosion rates are attributed to the lack of a significant source of littoral sand, the predominance of fine sediment, rapid rates of subsidence, and the frequency of hurricanes (Kuecher, 1994; Penland *et al*., 2005). Based on data from 1947-1999, long-term relative sea level rise at Grand Isle, approximately 64 km east of the HNC, is 9.2 mm/year with a 95% confidence interval of 0.59 mm/year (National Oceanographic and Atmospheric Administration 2008). Without a source of littoral sand in the regional coastal system, and with rapid subsidence, barrier islands in Louisiana have ultimately drowned (*e.g.*, Ship Shoal, Penland and Boyd, 1981). Regionally, net longshore sediment transport is generally from east-to-west, although reversals in direction can occur in the vicinity of inlets and passes and during storm events (*e.g.*, Suter and Penland, 1987; Dingler and Reiss, 1991; Debusschere *et al*., 1991; Jaffe *et al*., 1997).

[2] Mean Low Gulf (MLG) is a hydrographic tidal datum that includes local forcing due to tide, wind, current, and Mississippi River flow. As of June 2006, the relationship between MLG and National Geodetic Vertical Datum of 1988 (NAVD88) was established for various locations on the south shore of Lake Pontchartrain (Rigolets MLG=-0.202 m NAVD88; 17th Street Canal MLG=-0.161 m NAVD88; Bayou Labranche MLG=-0.114 m NAVD88) (Mugnier, 2006).

Louisiana is a low-energy coast with diurnal tides having a mean range of 0.4 m. Wave Information Study (WIS, 2009) data offshore of the project site in depth 20 m indicate a mean deepwater significant wave height equal to 1.0 m with a standard deviation of 0.6 m and peak wave period equal to 5 ± 1.4 sec for the 20-year period 1980-1999. Maximum conditions during this 20-year period occurred during Hurricane Juan on October 28, 1985 with significant height 8 m and associated peak period equal to 13 sec.

Approximately 20-30 cold fronts pass through the study area each year from September to May in the Northern Gulf of Mexico (Chaney, 1999). Storms that do not inundate the barrier islands erode sediment from the Gulf side of the barrier islands and deposit it offshore or alongshore. Waves generated by northerly winds of cold fronts, tropic storms, and hurricanes can subsequently erode bay side beaches and deposit sediment in the bay. These storms typically create a net volume deficit to the barrier islands. In contrast, storms such as extreme tropical storms and hurricanes that have wave conditions and storm surge that overwash or inundate the islands erode sediment from the Gulfside and deposit it on the bay side of the barrier island (Dingler and Reiss, 1991). Storms that overwash and inundate the islands are more likely to migrate the islands in the cross-shore direction. The frequency of tropical storms and hurricanes in Louisiana is approximately every 1.6 and 4.1 years, respectively (Neumann *et al*., 1978; Nummedal, 1982).

The HNC was constructed by the State of Louisiana's Department of Public Works in 1959. The State of Louisiana later requested that the U.S. Army Corps assume maintenance of the channel, and the Corps was authorized to maintain the channel for navigation under the River and Harbor Act of 23 October 1962. Maintenance by MVN was initiated on 27 November 1964 at original channel dimensions of 4.6 m MLG depth by 46 m wide from the Gulf Intercoastal Waterway (GIWW) at Houma, LA to Cat Island Pass, and 5.5 m MLG from Cat Island Pass to the Gulf of Mexico (USACE New Orleans District, 2007). On 23 August 1973, authority was given to increase channel depth to 5.5 m MLG and widen the channel to 91 m from Cat Island Pass to the Gulf of Mexico. This improvement was completed in July 1974. In 1998, Cat Island Pass was realigned approximately 360 m to the west to reduce channel shoaling and avoid future impingement by the migrating Timbalier Island. Presently, fine sand dredged from Cat Island Pass is placed at either of two single point discharge locations west of the channel (Figure 2). The placement region is between 3 and 4 km offshore of Cat Island Pass and is approximately 760 m west of the channel.

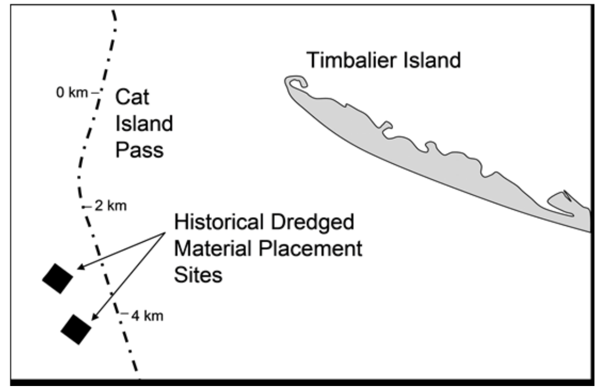


Figure 2. Location of dredged material placement sites west of Cat Island Pass.

PREVIOUS STUDIES

Based on morphological observations and bed form type and orientation, Suter and Penland (1987) discussed sediment transport pathways around Cat Island Pass. Generally, the morphology indicated net transport along Timbalier Island towards Cat Island Pass, which bypassed the inlet on the ebb tidal shoal towards East Island, although some was reworked to deposit in Cat Island Pass. The net longshore transport from east to west was evident from the well-develop swash platform west of Cat Island Pass. They concluded that the Cat Island Pass system "is not totally a sediment sink but does in fact interact with the adjacent barrier shorelines."

Suter and Penland (1987) also presented the minimum cross-sectional area of the Cat Island Pass complex as it varied from 1891 to 1986. These cross-sections indicate significant changes through the past century: (1) western Timbalier Island has continually migrated west into the Cat Island Pass complex through time; (2) Calliou Island and Calliou Pass, located between Cat Island Pass and Timbalier Island in 1891, were absorbed into the Cat Island Pass complex by 1934; and (3) the location of Wine Island Pass and eastern Isle Dernieres, both west of Cat Island Pass, have been relatively stable through time. The rate of migration for western Timbalier Island was 77 m/year to the west (1891-1934), 93 m/year to the west (1934-1974), and 58 m/year to the east (1974-1986). The average rate for the entire period is 67 m/year to the west.

Debusschere *et al*. (1991) monitored morphologic changes of the Isle Dernieres islands between 1984 and 1989 using an aerial videotape mapping system. Of pertinence to the study herein is that East Island recovered more rapidly after storms than the other portions of the Isle Dernieres. The authors attributed this recovery to the sediment supply available to East Island via bypassing across Cat Island Pass.

McBride *et al*. (1995) characterized geomorphic barrier island response using data from Louisiana, Mississippi, Georgia, and Florida. Data from Louisiana included an assessment of long-term shoreline change for Timbalier and East Islands. Between 1887 and 1988/89, the morphologic evolution of Timbalier Island was characterized as "lateral movement" to the west at a rate between 81.6 m/year (eastern portion) and 77.2 m/year (western portion). No changes were noted for the bayshore. On the west side of Cat Island Pass, the Isle Dernieres including East Island were characterized by McBride *et al*. (1995) as the "breakup" type of geomorphic evolution, indicating that the island system is susceptible to breaching during storms and disintegration. Shoreline change rates for the Isle Dernieres were erosion of the Gulf and Bay shorelines at -11.1 and -1.9 m/year, respectively.

Jaffee *et al*. (1997) analyzed 1930s and 1980s bathymetry offshore of present-day Cat Island Pass. Bathymetric change calculations and subsequent sediment sampling indicated a sandy deposit of 60 Million m^3. Jaffee *et al*. described this accumulation as massive sediment bypassing offshore of the 9-km-wide Cat Island Pass system and related it to “changes in shoreline orientation, closing of transport pathways to a large bay to the east and the presence of tidal inlets.” Numerical modeling of this system by Jaffee *et al*. indicated that bypassing was episodic, forced by large storms and hurricanes. Sediment sampling of the deposit showed that it was primarily sand. The authors predicted that erosion of Isle Dernieres, the barrier island system to the west, would likely decrease as sand continued bypassing via the large offshore deposit. The bypassing (accretionary) region evident in the 1930s-1980s comparison is erosive in the 1980s to 2006 bathymetric change data.

Stone and Zhang (2001) calculated potential longshore sand transport rates for Isle Dernieres and Timbalier Island using a wave transformation model for typical non-storm waves. The calculations indicate that sand shoaling in the HNC at Cat Island Pass should be approximately 38,000 m^3/year, whereas the average maintenance dredging quantity is approximately 5 times this rate. It is likely that inlet, storm, cross-shore transport, and fine sediment shoaling processes account for the difference between measurements and calculations.

ANALYSIS

Shoaling

To evaluate the historical shoaling rate at Cat Island Pass, the cumulative maintenance dredged volume for the “bar channel”, the portion of the channel crossing the ebb tidal shoal, was evaluated relative to the channel dimensions (Figure 3). Maintenance dredging records were analyzed as a proxy for natural shoaling in the channel. The slope of the cumulative volume trend line gives the average shoaling rate over a period of time.

Deepening (from 4.6 to 5.5 m) and widening (from 46 to 91 m) in 1974 increased channel shoaling from 66,000 to 223,000 m^3/year. However, realignment of Cat Island Pass to the west in 1998 was effective in reducing the shoaling rate to 190,000 m^3/year.

Several methods are available to estimate the increase in shoaling with channel improvement, including numerical models (*e.g.*, Kadib, 1976; Bijker, 1980; Van Rijn, 1991; Walstra *et al*., 1999; Reed *et al*., 2005), analytical methods (*e.g.*, Mayor-Mora *et al*., 1976; van de Kreeke *et al*., 2002; Rosati and Kraus, 2009), and empirical relationships (Gole and Tarapore, 1971; Trawle and Herbich, 1980; Trawle, 1981; Galvin, 1979, 1982; Vincente and Uva, 1984; Rosati, 2005a). For locations with three-dimensional processes requiring detailed analysis and for channels that are significantly modified from the existing condition, numerical modeling is the preferred method. Herein, because the proposed modification differs by only 10% from the existing cross-section, the change in channel shoaling after the previous deepening and widening was evaluated with an

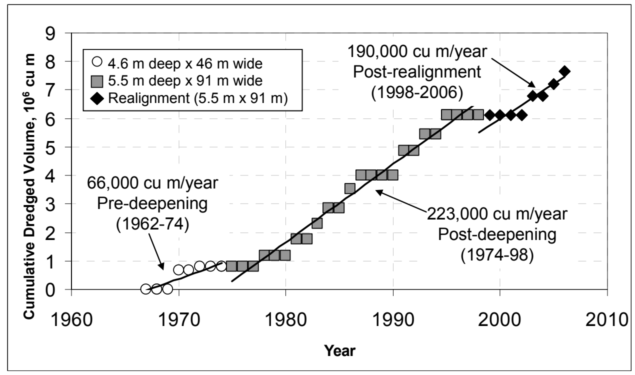


Figure 3. Cat Island Pass maintenance dredging rates evaluated for time periods corresponding to changes in channel configuration.

empirical relationship. Rosati (2005a) developed an empirical method that relates the increase in shoaling with channel improvement (deepening, widening, and lengthening) to the increase in dredged channel volume over the natural (pre-dredged) channel volume. The relationship was developed from 12 long-term (ranging from 8-75 years) shoaling rates from 7 coastal inlet navigation channels. The reasoning behind this concept is that natural coastal processes work to restore the channel to its original dimensions (the pre-dredged volume equal to depth × width × length) at a rate that is related to the difference between the natural and dredged volumes. The shoaling rate, S , is related to the increase in dredged volume as compared to the pre-dredged channel volume, V_d, as follows,

$$S{=}0.613\,V_d\,(year^{-1}) \tag{1}$$

Any consistent units may be used. To evaluate whether this relationship is applicable to Cat Island Pass, historical channel dimensions and shoaling rates were compared with Equation (1). Results of this analysis are shown in Table 1 and Figure 4 and agree well with a squared correlation coefficient equal to 0.974. The shoaling rate with the proposed improvement is estimated to increase approximately 15% from the existing maintenance dredging rate, or approximately 30,000 m^3/year. If Timbalier Island continues migration to the west, it is likely that the shoaling rate with the deepened channel will exceed this estimate unless the channel is realigned further west.

Channel Migration

The migration rate of the thalweg of Cat Island Pass as observed from the bathymetric data was estimated as 12.8 m/year (1930s-1980s) and 7.9 m/year (1980s-2006) to the west. It is likely that the location of the channel thalweg after 1967 is influenced by channel dredging and realignment in 1998. The migration rate for the earlier time period is probably more representative of natural channel migration, which is on the order of 12.8 m/year to the west. However, Timbalier Island

Table 1. *Channel Dimensions and Maintenance Dredging Rate, Cat Island Pass.*

Date	Channel Dimensions			Maintenance Dredging Rate (10^3 m^3/year)	
	Depth, m	Width, m	Length, km	Actual	Predicted
1959 – Natural Dimensions (estimated from 1930s bathymetry)	4.6	45.7	0.4	Equilibrium, ~0	0
1962 – 1974	4.6	45.7	6.2	66	75
1974 – 1998	5.5	91.4	6.2	223	187
1998 – 2006 (realigned)	5.5	91.4	6.2	190	187
Proposed (2010+)	6.1	91.4	6.6	?	220

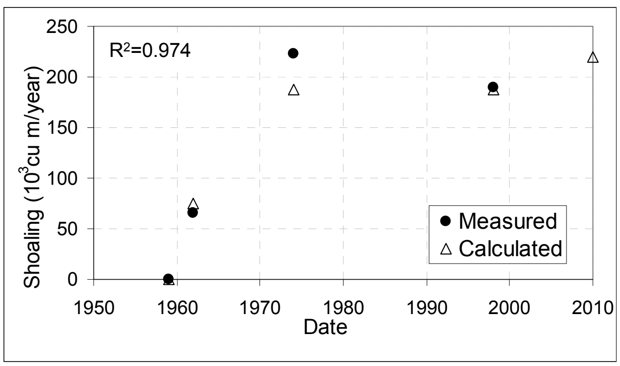


Figure 4. Comparison between actual and calculated shoaling [with Eq. (1)] at Cat Island Pass.

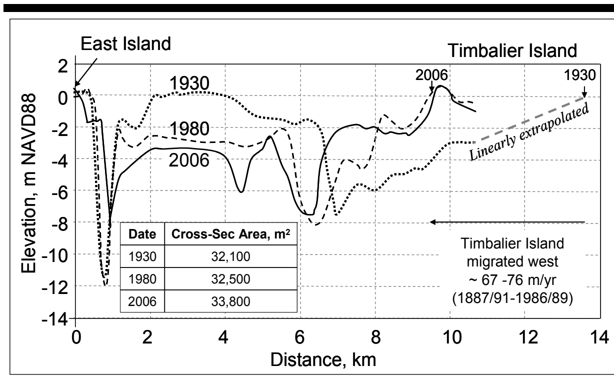


Figure 5. Minimum cross-sectional area for Cat Island Pass between East and Timbalier Islands.

has been migrating to the west more rapidly than the channel, estimated as 67 m/year from 1891-1986 (average based on Suter and Penland 1987), and 76 m/year from 1887-1988/89 (from McBride *et al*., 1992).

Tidal Prism

Tidal prism is defined as the volume of water that enters a tidal inlet during flood flow. Jarrett (1976) developed a relationship for tidal prism, P, as a function of inlet cross sectional area, A_c, which for Gulf Coast non-jettied or single-jettied inlets (Kraus, 2009) is,

$$A_c\,(m^2) = 6.992\text{x}10^{-4} P^{0.86}\,(m^3) \qquad (2)$$

The minimum cross-sectional area for Cat Island Pass has increased through time, approximately 32,100 m^2, 32,500 m^2, and 33,800 m^2 in 1930, 1980, and 2006, respectively (Figure 5). Applying Equation (2) with these cross-sectional areas implies that tidal prism has increased slightly, from 811 million m^3 in the 1930s, to 823 million m^3 in the 1980s and 862 million m^3 in 2006, an overall increase of 6%. A natural increase in tidal prism may result from changes in the dynamics of adjacent inlets, deepening of channels, as well as an increase in bay area such has occurred in Louisiana with erosion and wetland loss (Howard, 1982; Levin, 1993; FitzGerald *et al*., 2004, 2007, 2008; Flocks *et al*., 2006; and others). With channel deepening, increase in the minimum cross-sectional area of Cat Island Pass would be only 0.2% of the 2006 area, and would not have any discernable effect on the tidal prism.

Morphologic Change and Sediment Transport Pathways

Bathymetric and shoreline data from 1930, 1980, and 2006 were applied to evaluate morphology change in the vicinity of Cat Island Pass. These calculations along with knowledge gained through the literature review were applied to develop likely transport pathways. These pathways are conceptualized in Figure 6 using the 1980s to 2006 (and 1930s to 1980s to extend coverage west) morphologic change, as well as information from previous studies. It is emphasized that pathways shown in

Figure 6 represent one possible solution to the likely patterns of sediment transport in the area, and that other viable solutions could also be formulated. Warmer colors (red to yellow) indicate transport pathways and deposition; cooler colors (light to dark blue) show areas of scour or erosion. The pathways were developed by assuming that sediment moves from blue areas to red, and is transported along and deposited within red areas. Arrows represent directions of sediment transport for conditions when sediment is mobilized in these regions. Transport pathways may repeat and reverse during typical tidal cycles. This conceptualization indicates that there may be transport of the dredged sediment from the placement site back into the channel.

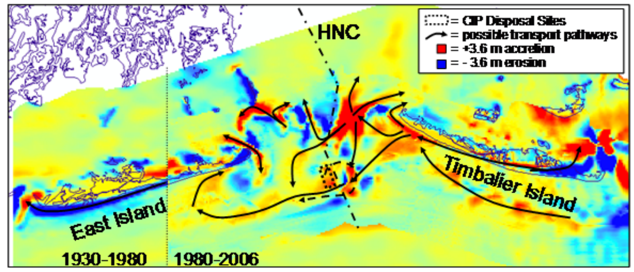


Figure 6. Conceptualized sediment transport pathways and corresponding volume change for Cat Island Pass region.

Sediment Budget

A sediment budget is an accounting of gains and losses within a specified area (cell), or a series of connected cells, over a given period of time (Dolan *et al*., 1987; Kana and Stevens, 1992; Rosati, 2005b). The difference between sources (inputs) to and sinks (outputs) from a cell must equal the rate of observed volume change in that cell, including all engineering activities,

$$\sum Q_{source} - \sum Q_{sink} - \Delta V + P - R = 0 \tag{3}$$

Where Q_{source} and Q_{sink} are the sources and sinks to the cell, respectively, ΔV is the volume change in the cell, P is any placement (*e.g.*, dredged sediment placement or beach nourishment) in the cell, and R is any removal (*e.g.*, dredging) from the cell. Typically, sediment budget cells are defined to represent a morphologic region (*e.g.*, barrier island, ebb tidal shoal) or specified such that the cell is located at regions of known transport rates (*e.g.*, jetty structure, dredged material placement sites).

The sediment budgets developed herein focused on the barrier islands and morphology of Cat Island Pass (Figure 7). The historical and with-deepening budgets each represent one possible solution given the known volumetric change and typical coastal processes at the site. The historical data indicate subaerial erosion (Timbalier and East Islands) totaling 292,000 m^3/year and accretion of sub-aqueous features of the same magnitude (Figure 7a). There is no littoral sand source that naturally transports to this region except through erosion of the islands. Migration of Timbalier Island and Cat Island Pass is evident in transport pathways and accretion to the west of Timbalier Island. An average of 191,000 m^3/year is deposited in the channel and dredged from Cat Island Pass, and this quantity is placed west of the channel in the placement site. The sediment transport pathways in Cat Island Pass are complex. It is likely that the present disposal area returns sediment to the channel. For the sediment budget, it is assumed that approximately 15,000 m^3/year remains in the placement site, with the remaining 75,000 m^3/year transported back into the channel and 101,000 m^3/year transported west towards the downdrift shoal. East Island receives 23,000 m^3/year of sediment from the ebb shoal, which is eroded from the island in overwash to the bay and transport off the west terminus.

The with-deepening sediment budget was developed by modifying the historical sediment budget to reflect an anticipated increase in channel shoaling of 30,000 m^3/year (Figure 7b; circled values show differences between historical and with-deepening budgets). With the deepening, maintenance dredging is estimated to increase to 220,000 m^3/year, which would be placed in the designated dredged material disposal site. Based on the sediment transport pathways, it was assumed that the additional shoaling in the channel was intercepted from the natural bypassing of Cat Island Pass. As a result, transport to East Island and adjacent shoals would decrease, increasing erosion of East Island to 30,000 m^3/year.

Alternative Placement Sites

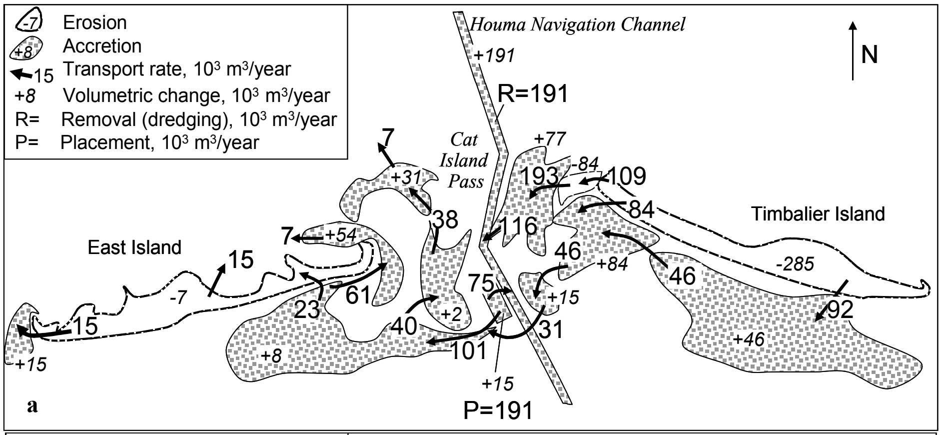
The sediment budget indicates that movement of the dredged material placement site further west would increase bypassing to East Island and decrease rehandling of dredged sediment. Ideally sediment would be placed directly on East Island, with sand placed on the Gulf beach and fines place on the bayshore. However, dredging equipment and increased cost for subaerial placement may make this infeasible. Figure 8 shows some alternative locations for placement sites that would increase the rate of sediment transported towards East Island.

SUMMARY AND CONCLUSIONS

This study was performed in support of U.S. Army Corps of Engineers District, New Orleans to provide preliminary estimates for how deepening the Houma Navigation Channel at Cat Island Pass would change historical shoaling rates, determine the source of any shoaled sediment, and make recommendations for placement of the sediment. A literature review was conducted as well as desk-top analyses to develop historical and hypothetical with-deepening sediment budgets. The study is the first that has quantified the magnitudes and directions for sediment fluxes and associated volume changes in a sediment budget for the Cat Island Pass region, and applied this knowledge to postulate a sediment budget including navigation channel improvements.

This study had the following findings:

- Deepening and lengthening the HNC at Cat Island Pass will increase the maintenance dredging from 190,000 to 220,000 m^3/year, or approximately a 15% increase. It is



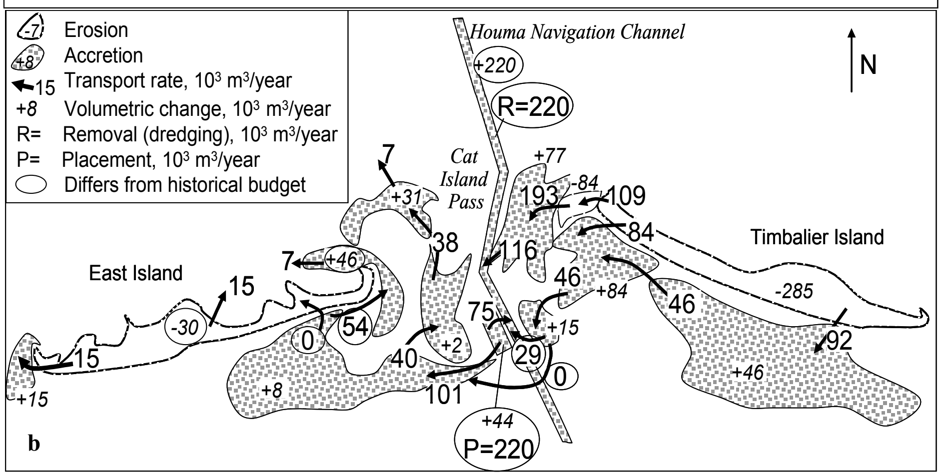


Figure 7. Historical and with-deepening sediment budgets based on 1980s to 2006 volumetric change, (a) Historical sediment budget, (b) With-deepening sediment budget.

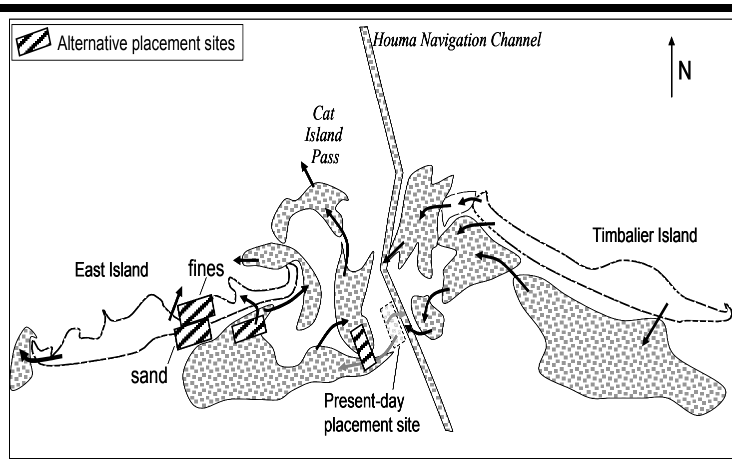


Figure 8. Alternative placement sites to increase bypassing to East Island.

likely that this maintenance dredging rate will increase in the future due to migration of Timbalier Island to the west unless the channel is realigned further to the west.

- Historically, the source of the shoaled sediment in the channel has been from the east, via erosion of the LaFourche headland and transport along Timbalier Island, to the ebb tidal shoal and across the channel. Previous studies as well as the historical sediment budgets indicate that natural bypassing from Timbalier Island, through Cat Island Pass, to East Island and the Isle Dernieres occurs. With channel deepening, it is anticipated that these transport pathways east of the channel will continue, although the deeper channel will intercept a portion of the natural sand presently bypassing the channel and increase shoaling by 30,000 m^3/year.
- Estimates for migration of Cat Island Pass range from 8 m/year (1980s to 2006) to 13 m/year (1930s to 1980s) to the west. It is likely that channel position after 1967 was controlled by dredging; thus, the better estimate for natural channel migration is approximately 13 m/year. However, Timbalier Island is migrating west more rapidly, at 76 m/year.
- The tidal prism through Cat Island Pass was estimated to have increased 6% from the 1930s to 2006 due to natural deepening of the pass, changes in dynamics between adjacent inlets, and an increase in bay area due to erosion and wetland loss. It was estimated that tidal prism will increase by an insignificant amount due to the increase in channel area as a result of deepening.

Recommendations from this study are as follows:

- Sediment dredged from Cat Island Pass should be placed on East Island, downdrift of the channel. If logistics permit, it is recommended that fine clay and silt be placed on the bay side of the island in locations of existing overwash fans, narrow portions of the island, or to fill any abandoned canals that weaken the island. The sediment could be pumped into a diked area to allow settlement of the slurry while dewatering. Sand compatible or coarser than the native sand on East Island should be placed on the Gulfside of the island, far enough to the west such that it will not transport to the east and shoal in the channel.
- Depending on cost, it may be feasible and desirable to realign Cat Island Pass further to the west to minimize future dredging. Estimates are that Timbalier Island continues to migrate west into Cat Island Pass, which will bring the sediment source for channel infilling closer to the channel through time. Also, realignment of Cat Island Pass further to the west will better facilitate logistics of placement of dredged sediment on East Island.
- If sediment cannot be placed on the islands, and the placement locations west of the channel continue to be used, it is recommended that these locations be sited further away from the channel than the present sites 760-m west of the channel, and sited as close to the barrier islands as possible. With the complex sediment transport pathways in Cat Island Pass, it is likely that the present location of these disposal sites returns sediment to the channel.

Based on the results of this and other studies of the Houma Navigation Channel, channel realignment was approved in 2009, and authorization of the deepened channel is being requested during 2010.

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